SUPPLEMENT
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BRITISH ASSOCIATION OF GAS MANAGERS.

SEVENTEENTH ANNUAL MEETING.

THE aspect of the Hall of the Institution of Civil Engineers at the commencement of the proceedings of the Annual Meeting of the Members of the British Association of Gas Managers on Tuesday morning last, was such as to presage no ordinary success for the gathering which was then about to be inaugurated. In the first place, the hall itself—for the use of which the Association is indebted to the kindness of the Council of the Institution, who with their Secretary, Mr. Forrest, showed the Committee of the Association the utmost courtesy in the course of this, their first direct relationship—was a decided improvement, for the purposes of the meeting, upon the theatre of the Society of Arts, where the London meetings of the Association have been held in previous years. The hall is cheerful and well lighted, and furnished with every facility for the reading of papers and the delivery of lectures, and the members had much reason to be pleased with the accommodation provided for them. The attendance was from the commencement very good, even for a London meeting, which gratifying circumstance was, let us hope, due in no small measure to the great richness and variety of the scientific aliment promised in the list of papers to be read. A universal feeling of favourable expectation seemed also to prevail respecting the Inaugaral Address of the President, Mr. Charles Hunt, who is generally credited with the power of dealing with the subject matters of his profession in a manner at once vigorous and original.

The interest deepened in a marked degree when, with commendable punctuality, the President began the delivery of his most interesting address, which appeared in the supplement to last week's issue of the JOURNAL. At this time the hall was fairly filled, and thanks to the clear enunciation with which the address was read, it could be followed with perfect ease by every person present. Commencing with a brief reference to the circumstances under which he found himself unexpectedly called upon to assume the presidential chair, Mr. Hunt did not dwell long upon the personal details which have first to be mentioned in addresses of this kind; but he still found words to express the cordial sympathy with which the return of Mr. Bennett, the esteemed Secretary of the Association, to his active duties in connection with the meeting, after his late severe illness, must be generally greeted; and to allude feelingly to the deaths of Mr. Fewtrell, late of this JOURNAL, and of several other friends and members of the Association who have passed away during the year just gone by. The continued vitality of the Association, shown in its most satisfactory increase in numbers during the last decennial period, was then pointed out, and its present objects and utility briefly explained, the President passing on immediately to give his views of the direction in which the operations of the Association might, in his opinion, be best extended.

That continued growth, in organizations of this kind, is absolutely essential, no one will be disposed to deny. Without it, stagnation and ultimate decay are inevitable. The accretion of new members in increasing numbers forms one kind of growth; but some constitutional progress besides and apart from this is not only desirable but necessary, to keep up the interest of members imbued with the mutability of human nature. During the past decade, the establishment of district associations of suitably modified constitution, but with identical objects, has, to some extent, if not altogether, to be considered as a growth of the parent Association. But the growth of the ensuing ten years, as it cannot, in the nature of things, be of a similar character, demands careful, not to say anxious consideration, on the part not only of those who are officially responsible for the well-being of the Association, but of all the members, individually and collectively. Mr. Hunt's suggestion that the collected Proceedings of the Association should embody a complete record of the progress of the science of gas lighting all over the world is good, but, from the character of the subject, is likely to be very costly in execution. His second suggestion—that the Association, as a body, should assume a directive attitude respecting original research, by assisting experimentalists, or by appointing Special Committees to follow out certain lines of investigation which might be indicated by the profession generally as likely to add to the common stock of information—appears far easier of adoption, and this without prejudice to the undoubted value of the former idea. No great expense or fundamental change in the constitution of the Association would be necessitated by the adoption of this latter proposal, if it may be so termed in its present form, and it is a feature of striking importance in the method of working of the German Gas and Water Works Managers Association, and, as such, has been frequently mentioned in these columns. And in furtherance of this suggestion, nothing could be more apparent in the tenour of several of the papers subsequently read at the meeting, and still more conspicuously in many of the discussions, than a general consensus of opinion that more independent and reliable testimony is needed respecting certain seeming mysteries and novel processes in gas engineering, than is obtainable under the present system. It was certainly surprising to see how many comments and even criticisms, expressed in the course of the two days devoted to reading and discussing papers, became explicable by the application of this feeling as a key to the speakers aspirations; and it is therefore to be expected that any definite proposition of the kind would be met with much cordial appreciation. It may well be hoped that active measures of this kind, leading to definite advancement of knowledge, would be even more satisfying to a living association than any work of a mere chronicling or cataloguing character.

The mention made by the President of one of the effects of the amalgamation of the London Gas Companies—namely, that of the ensuing extinction of manufacturing stations in cramped and populous localities—is interesting in relation to the question of the nuisance arising from these works. Such nuisance as may be found inevitable from the operations of gas-making as at present conducted, is at once rendered unimportant when the works are established in remote places, which is the practical outcome of the amalgamation movement. Gas should certainly be rendered as pure as possible before being supplied to the consumer, and it is evidently desirable that the processes by which this end is achieved, being usually somewhat obnoxious, should not be carried on under his nose.

The electric light, of course, occupied some share of the President's notice, and it was pleasing to observe the manly treatment which it received at his hands. Without indulging in any cheap but dangerous prophecy, which in his peculiar case, and before such an audience, might have easily become claptrap, he brought forward some interesting facts on the subject which distinctly bore in favour of gas, at the same

time that he expressed his hearty goodwill for the development of the electric light in realms which it might make conspicuously its own.

Perhaps the most useful portion of this most able address, in regard to the progress of gas lighting at large, is to be found in the striking remarks in which the simple, old-fashioned question of the extended use of gas as a domestic luminant in competition with oil-lamps was at once invested with the commanding interest which is its due, but which, in these days of effort for new applications of gas for other and formerly unheard-of purposes, runs considerable risk of fatal neglect. While the consumption of gas for what may be called legitimate purposes ranges in towns similarly circumtanced from 2000 to 4600 cubic feet per head of population per annum, it would be obvious folly on the part of the gas producers of the former localities to seek for novel and revolutionary expedients for extending their business, while remaining so far distanced by other traders in the line in which their primary efforts must be always exerted. Legislative protection should never, as a set-off against the benefits which it confers, cause such a numbness and partial paralysis as is revealed by the existence in any cases of such positive failing in duty, as well as in business aptitude, to which alone the above disastrous comparison is due. That any Gas Companies should be restricted in development by a morbid fear of incurring bad debts, is a principle comparable only to that acted on by a man who objects to bathe until he can swim, for fear of being drowned if he goes out of his depth.

The subject of heating retorts by gaseous fuel was not overlooked by Mr. Hunt, who has upon former occasions expressed his approval of the new system as a distinct and notable advance in the process of carbonizing coal. This class of furnaces, being all simplifications, and to some extent imperfect embodiments of the Siemens regenerative gas-furnace, and which received attention in the course of the subsequent proceedings, when the members had the privilege of being addressed by the distinguished originator of the system, is becoming in more than one sense a "burning question" with English Gas Engineers. It is sometimes said that Englishmen are slow to adopt inventions which they did not themselves originate, although they are not so tardy when they can improve on the original ideas so much as to make them practically their own private property. In this case we are certainly behindhand in comparison with our neighbours across the Channel and beyond the Rhine; and as we have begun to confess this truth, let us see that the second observation will also hlod good. In one small matter only will we offer a correction of the President's remarks. The radiation from these furnaces is not so considerable as he appears to suppose, the walls being constructed with a non-conducting layer, which greatly reduces this otherwise serious defect in a separate structure.

With respect to mechanical stoking, the Presidential utterances were brief yet cogent. The manner in which the practical success of any appliance of this kind was shown to depend upon the preliminary treatment of the coal, reminded one of the fact that the substitution of an eye near the point of a needle, instead of at the end, rendered the construction of sewing-machines practicable. On such seeming subsidiary discoveries does mechanical progress depend.

Condensation is becoming a problem of the day in relation to the preservation of the illuminating power of gas from unintentional deterioration, and it was not surprising to find Mr. Hunt devoting some pains to express his ideas on the subject. As the matter was fully discussed later, it may suffice here to observe that it may happen that the researches now being carried out by Mr. Greville Williams, under the auspices of Mr. R. Morton, go far to corroborate Mr. Hunt's general opinions on this matter. If it should be experimentally proved that the contact of gas with tar at high temperatures is worth securing in practice, it does not appear difficult to so far modify the present hydraulic main as to make it perform to some extent the work of partial distillation of its contents, by the aid of heat derived from the retort stack.

Mr. Hunt's remarks on the unfortunate way in which gas producers have in past times allowed themselves to be divorced from gas consumers, should be taken to heart by all those to whom his previous observations respecting restrictive regulations and obstructions to the free use of gas must have appeared almost personally directed. While acknowledging the value of the suggestion that general powers should be conferred on Gas Companies, and other gas manufacturers at present working in legislative leading-strings, to let on hire to their customers any appliances for the better utilization of their product, it is impossible not to feel that very much in the way of assisting or instructing the consumer may be done without parliamentary authority. Mr. Hunt acknowledged this, and the acknowledgment may with most people be extended to include the general proposition that in this, as in other things, where there is a will to act, the means are generally found at hand. No amount of pressure can compel people—gas manufacturers or others—to act in the true spirit of legislation with which, in their hearts, they do not agree. Let us take it for granted that all gas manufacturers have a real desire to extend their business, although the proceedings of some among them would at first sight appear to contradict this assumption, and then we shall have to believe that in many cases the manufacturers themselves require educating in this matter before they can educate their customers.

The President dealt in general terms only with reference to the use of gas as a direct motor in the gas-engine, dwelling chiefly on the surprisingly close approximation to the theoretical power of heat as a mode of motion which these motors have practically yielded, even to the present time, although their successful development is one of the very latest mechanical achievements of the day. The President struck another key-note when he expressed the hope that gas manufacturers themselves would employ these engines more generally in their own works, and thereby, in the most practical manner possible, help in popularizing their use by the public. It has formed a well-grounded grievance to the inventors and manufacturers of gas-engines, that gas producers, although possessing such an interest in the successful introduction of these machines, have allowed the makers of them to bear the entire onus of proving to a sceptical public, not only the advantages of the machines themselves, but also the safety and economy of the use of gas in this form. This latter is now a universally accepted fact, but not by virtue of any great efforts on the part of those who will reap the profit of supplying the raw material for transformation into power.

The vexed question of ventilation in houses always puts on a more complicated aspect when illumination by gas is taken in connection with it. Yet, viewed in a proper light, to use a pun of the very mildest character, gas may be made, instead of aggravating the difficulty, to show a ready way out of it. The heat of gas burned primarily for light is properly a very valuable accompaniment of it, as giving the means of controlling currents of air, which may be utilized in removing, in a perfectly unobjectionable manner, all the products of combustion from confined spaces, and also to ventilate the apartment at the same time more efficiently than any other agent known. Speaking of common expedients for using gas to heat rooms, by appliances variously known as gas-fires, "cheerful" gas-stoves, and other devices of a similar kind, the President was righteously in favour of gas-stoves which boldly aim at making the best use of the material on its own merits, and not dressing it up to look like something which it is not, and which, moreover, it never can be made to imitate successfully, save in points in which the thing imitated is itself most objectionable. We do not disguise a gas-lamp to make it look like a rushlight, and there is no sufficient reason for making a bad imitation of a coal fire, with the attendant waste of as much valuable gaseous fuel as, when properly applied, would do all that is needed.

Finally, Mr. Hunt briefly touched upon the improvements in gas-burners which have recently attracted so much attention within and without the ranks of his professional brethren. The value of the heat evolved in the combustion of gas, as an index of the possible intensity of the light produced, is a question which bids fair to assume a position of paramount importance in the immediate future. Brilliant light is a manifestation of intense heat, and without the latter the former is unobtainable. So far there is no dispute; but we cannot so certainly reverse the proposition, and say that intense heat is necessarily accompanied by brilliant light. The one phenomenon may exist without the presence of certain factors which go to make the other. How far these factors may be manipulated in practice has yet to be determined. We have lately seen an addition of 30 per cent. of light produced by modifications in the treatment of the same quantities of gas and air, and this large advance on what was once considered practical perfection, should make us hesitate to assign limits to progress in the same direction. But the fact that progress is accepted as possible, is a matter for mutual congratulation between the producers and consumers of the material, to the improvement of which such wide bounds can alone be set. The utility of gas will never be circumscribed, and the science of its production will never be finite, while its capabilities in even one of its manifold applications are still

undetermined. Infinity of usefulness and in power of development is a large qualification—too large for application to any of the substances, manufactured or otherwise, known to man. We would be far from seeking to claim it for gas, but we do hold that the limit of its useful development is at present scarcely even to be surmised. And it is only due to Mr. Hunt to say that, in concluding his admirably lucid and comprehensive address with considerations such as these, he was not indulging in a vain and inconsequent peroration, but was simply formulating truths which patient listeners to his previous remarks must have felt when considering how the future—always the future—for the work that is to be done in it, was the Golden Age to which the President's hopeful outlook was directed. There was none of the lingering fondness for a past of leading-strings, which would have been so appropriate in an apologist for a declining art; no feeble deprecation of wholesome competition was there; but instead of fear there was confidence, instead of regrets there were hopes; the past and present were almost despised in anticipation of the fruition of the time to come; and all this was based, not on wild imaginings or vainglorious assertions, but upon solid facts which are patent to all.

After the delivery of the address, which was received with warm appreciation, came the reading of papers in the order as printed to appear in the JOURNAL, and subsequently in the Transactions of the Association. We shall reserve our comments on these various contributions to contemporary science until their appearance in our columns.

The lecture on Tuesday evening, by Mr. Greville Williams, F.R.S., on "The Past, Present, and Future of Coal Tar," was well attended, and the lecturer's most interesting description of the various compounds made with the constituents of that extraordinary substance was very well received. Some of the lecturer's reminiscences in connection with the early discoveries of substances previously undreamt of, in the unpromising-looking material of which he confessed himself so fond, were very entertaining; and the recital of some of the complex processes by which the more occult preparations are separated and purified, was calculated to impress his hearers with the feeling almost of reverence for the patience, amounting truly to genius, and the skill by which those processes were so laboriously worked out; and it would be impossible to disagree with the sanguine expectations which he expressed regarding the further discoveries that the same means may yet make in connection with a product which, within recent times, was quite worthless. Gas managers may possibly demur to the suggestion that coal will ever be distilled mainly for the tar which it yields; still, to a large and increasing class of manufacturers, the tar is even now held in such importance that they would scorn to term it a "residual product."

The last event to be chronicled in connection with this year's meeting, but by no means the least in interest and importance, was the visit made by the members to the Beckton station of The Gaslight and Coke Company. Leaving London Bridge on Thursday morning by the saloon steamer *Alexandra*, the members and their friends, to the number of over 400, were enabled to spend several hours of a pleasant day in the inspection of these works, which are yearly becoming more complete. The greatest attention was shown to the visitors by Mr. F. J. Evans (one of the Directors of the Company), Mr. Trewby, Mr. Wyatt, and the numerous gentlemen officially connected with the works, who conducted the party over the vast establishment. Great extensions have been made in the buildings and apparatus since the occasion of the last visit of the members of the Association, and the process of expansion is going on so rapidly that, as Mr. Wyatt remarked, in a very few years Beckton will be twice as large as it is at present. But even now it is difficult to properly realize its full dimensions, and, in fact, this can best be done by noting the scale on which the residual products have to be dealt with. The extensive chemical works which form the latest phase of the development of the establishment are admirably qualified to bring into one comprehensive view the magnitude of the operations to which they are an appanage. Here were seen in bulk some of the principal substances on which Mr. Greville Williams had previously dilated, and had it not been for that gentleman's remarks, it might have appeared to some of the visitors the easiest thing in the world to manufacture anthracene, carbolic acid, benzene, and the other articles produced in these works under Mr. Fenning's superintendence. With this interesting part of the programme the pleasurable business of the day was brought to close. The visitors having been photographed, and partaken of the hospitality of The Gaslight and Coke Company, returned in the steamer to North Woolwich, where luncheon was served in the gardens, and finally reached London Bridge, where, with their dispersal, terminated one of the most successful meetings which the members of the Association have ever enjoyed.

REPORT OF PROCEEDINGS.

TUESDAY, JUNE 8.

The Seventeenth Annual General Meeting of the Members of the Association commenced this day, at the Institution of Civil Engineers, Great George Street, Westminster—CHARLES HUNT, Esq., C.E., of Birmingham, in the chair.

The minutes of the previous meeting, and the statement of accounts, which had been printed and circulated among the members, were taken as read.

The SECRETARY (Mr. W. H. Bennett) read the names of the gentlemen proposed for membership, and the motion—"That the gentlemen whose names have just been read be elected members of the Association," was agreed to *nem. con.* The following is the list:—

ORDINARY MEMBERS.

Algeo, R.	Menai Bridge.
Anderson, T., jun. .	Bath.
Askew, B.	Northwich.
Bennett, C. V. . .	Ramsgate.
Blackburn, C. H.. .	Rawul Pindee, India.
Brookman, A. H.. .	Tenby.
Coulson, W. . . .	Hornsea, near Hull.
Deane, W. A. . . .	Richmond, Surrey.
Dougall, A., jun. . .	Radcliffe.
Gough, A. L. . . .	Guayaquil, Ecuador.
Greaves, T.. . . .	Melton Mowbray.
Green, G.	Hoddesdon.
Hardie, W., jun. . .	North Shields.
Harrison, C. . . .	Accrington.
Heydon, J.	Mansfield.
Humphrys, F. C. .	Ilkeston.
Humphrys, N. H. .	Westbury.
Iremonger, C. . . .	Ventnor.
Jones, H. E. . . .	Commercial Gas-Works, Stepney.
Kemp, R.	Bagshot.
Lloyd, E. J. . . .	Dudley.
Miles, J..	Melton Mowbray.
O'Farrell, J. G. . .	Newbury.
Parker, T. D. C. . .	Hong Kong, China.
Phillips, W. H. . .	Padstow.
Pike, H. S. . . .	Hinckley.
Porrie, C. E. . . .	Slough.
Simmons, C. W. . .	Carshalton.
Tetlow, J.	Rastrick.
Thompson, R. . . .	Melbourne, Australia.
Vinson, W. E. . .	Gloucester.
Wells, W.	Farnham.
White, D.	Bangor.
Wright, E. A. . . .	Brecon.

EXTRA-ORDINARY MEMBERS.

Glover, J. W. . . .	Royal Avenue, Chelsea.
Macpherson, D. D. .	Manchester.
Owens, S.	Whitefriars Street, London.

INAUGURAL ADDRESS OF THE PRESIDENT.

The PRESIDENT then delivered his Inaugural Address, which appeared in the supplement to last week's JOURNAL. In the course of it he announced, in reference to the progress made, by the Association during the year just ended, that the elections at this meeting—after making the necessary deductions for removals, and for the loss by death of five members—brought up the total number of members to 702.

AWARD OF THE MEDAL OF THE ASSOCIATION AND PREMIUMS FOR LAST YEAR'S PAPERS.

The PRESIDENT announced the award by the Committee of the medal of the Association to Mr. W. Sugg, for the paper he read at last year's meeting, on "Lighting by Gas and Electricity;" also the first premium of £10 to Mr. W. Carr, for his paper on "Gas-Engines;" the second of £7 to Mr. J. W. Sandeman, for his paper entitled "Economy in the Manufacture of Concrete, with Remarks on its Application to the Construction of Gasholder Tanks;" and the third to Mr. W. Cowan, for his description of "The Automatic Pressure Changer."

APPOINTMENT OF SCRUTINEERS.

Messrs. C. L. Hartley (Middleton) and P. Simpson (Rugby) were appointed Scrutineers of the votes for the election of Office Bearers of the Association for the coming year.

READING OF PAPERS.

The reading of papers and communications was then commenced. These we shall, as in former years, now enumerate in the order in which they were taken, leaving the printing of them and the discussion upon them, for subsequent numbers of the JOURNAL. The order in which the papers were read was as follows:—

Tuesday Morning.

1. "Some Experiments on the Thermal Power of Gas Cooking and Heating Apparatus." By Mr. T. Travers, of Cork.
2. "Testing Gas Coals." By Mr. Harrison Veevers, of Dukinfield.

Tuesday Afternoon.

3. "Retort Furnaces." By Mr. Frank Livesey, of the South Metropolitan Gas-Works.
4. "Regenerative Furnaces, as applied to the Heating of Retorts." By Mr. G. E. Stevenson, of Peterborough.
5. "The Construction of Gasholders." By Mr. G. Barker, of Birmingham.

Wednesday Morning.

6. "Statistics of Working Results." By Mr. G. E. Stevenson, of Peterborough.
7. "Gasholder Tanks: Difficulties and Mistakes in their Construction." By Mr. George Livesey, of the South Metropolitan Gas-Works.
8. "An Apparatus for Preventing the Oscillation caused by the Exhauster, and for the Removal of Tar." By Mr. John Somerville, of the South Metropolitan Gas-Works.

Wednesday Afternoon.

9. "Standard for the Estimation of Illuminating Power." By Mr. F. W. Hartley, of London.
10. "The Chemistry of Spent Lime." By Mr. W. Foster, M.A., F.C.S., &c., Professor of Chemistry at the Middlesex Hospital.

[A paper on "Concrete Tanks," by Mr. W. Romans, of Sheffield, was, for want of time, taken as read; while the other paper announced—one by Mr. G. Bray, of Leeds, on "Some Fallacies Regarding Gas-Burners, with Remarks on Street Lighting"—was withdrawn because the state of his health would not allow him to proceed with the experiments necessary to check his results before presenting them at the meeting.]

LECTURE—EVENING MEETING.

In the evening a lecture on "The Past, Present, and Future of Coal Tar" was delivered, before a very appreciative audience, by GREVILLE WILLIAMS, Esq., F.R.S., &c. The lecture, a report of which will be found on p. 945, was illustrated by some highly-successful experiments that were received with much applause; and at its conclusion a hearty vote of thanks was passed to the lecturer, on the motion of the PRESIDENT, seconded by Mr. W. J. WARNER.

WEDNESDAY, JUNE 9.

After the reading of papers noted above, the following general business was proceeded with:—

ELECTION OF OFFICERS.

The report of the Scrutineers was to the effect that the following gentlemen had been elected Office-Bearers for the ensuing year:—

President.—Charles Hunt, Esq., of Birmingham.
Vice-Presidents.—Messrs. G. W. Stevenson (London), R. O. Paterson (Cheltenham), and R. Harris (London).
Treasurer.—Mr. H. Newall.
Secretary.—Mr. W. H. Bennett.
Committee (to replace those going out of office by rotation).—Messrs. W. Ford (Stockton-on-Tees), W. A. Valon (Ramsgate), and J. Tindall (Walsall).
Finance Committee.—Messrs. G. Livesey, C. Woodall, and J. Eldridge.
Auditors.—Messrs. Alfred Hersee and Alfred Lass.

The PRESIDENT said he hardly knew whether he ought to thank the meeting for having imposed upon him another year of work; for he began to think that the performance on one occasion of the onerous duties of the office of President was quite enough for any one. Nevertheless, he did thank the members from the bottom of his heart for the very high honour they had conferred upon him, and it was his earnest wish that this time next year they would not have to say that either the honour, or the dignity, or the usefulness of the Association had suffered at his hands.

MEMBERS IN ARREAR.

The SECRETARY then read a list of the names of gentlemen who had neglected to pay their subscriptions for two years, exclusive of the current year, and who were thereupon struck off the list of members.

PLACE OF NEXT YEAR'S MEETING.

Mr. P. SIMPSON (Rugby) moved that the meeting next year be held at Birmingham. It was, he said, true that the Association had met once before in Birmingham, and that might, with some people, be made an objection to agreeing to his proposal; but it was a long time ago, when the Association was very small (only 37 in number); and, in fact, it was then quite a different society to what it was at the present time. Birmingham was the centre of the gas manufacturing industry, and it was a very suitable place in which to hold the meeting.

Mr. BARRATT (Grantham) seconded the motion.

Mr. E. GODDARD (Ipswich) supported the resolution. He said he was present at Birmingham on the former occasion, and he was quite sure the Association would receive a hearty welcome if they agreed to go there again.

No other place being proposed, the motion was put and agreed to.

The PRESIDENT said that he took their unanimous selection as a great compliment to himself; and he would join his efforts with those of his fellow-members in the Midland Counties to give the Association as hearty a welcome as possible—not in a spirit of munificence, if he might be allowed to use the word, nor as endeavouring to outrival the generous hospitality they had experienced in other localities; but none the less, he hoped, having in view the true objects and interests of the Association.

VOTES OF THANKS.

The PRESIDENT next proposed a vote of thanks to the readers of papers, which, he said, he was sure would not suffer by comparison with those read at previous meetings.

Mr. W. CARR (Halifax) seconded the resolution, which was carried unanimously.

Mr. C. R. MEAD (Sutton) moved a vote of thanks to the Committee, saying that those who had never filled the office could hardly tell the amount of duties the gentlemen on the Committee had to undergo.

Mr. R. DARNEY (Faversham) seconded the resolution, which was also carried unanimously.

Mr. CORBET WOODALL proposed a vote of thanks to Mr. Henry Newall for continuing to act as Treasurer. As a member of the Finance Committee, he said he could testify to the great interest which Mr. Newall had always taken in the Association. Their financial affairs had recently been under special consideration, and whatever this might issue in, he was sure the Association would always retain a very pleasant and grateful recollection of the valuable services which Mr. Newall had from the first rendered.

Mr. E. GODDARD seconded the motion. He said, as one of the Trustees, he had had a good deal to do with Mr. Newall in his capacity as Treasurer, and he could only say that the way in which he had always conducted the treasurership had been highly commendable.

The motion was carried unanimously.

Mr. J. SOMERVILLE proposed a vote of thanks to the Scrutineers, which was seconded by Mr. J. ELDRIDGE, and carried unanimously.

Mr. SIMPSON, as one of the Scrutineers, suggested that in future four should be appointed in place of two, as they would then get through the work in half the time, and it would not be such a tax on those who undertook the duty.

Mr. T. NEWBIGGING (Manchester) moved a vote of thanks to the Auditors. They all knew that Mr. Lass was a most able professional accountant, and Mr. Hersee also was a very competent auditor.

Mr. E. GODDARD seconded the motion, which was carried unanimously.

The PRESIDENT next moved a vote of thanks to the Institution of Civil Engineers. He said the Association had hitherto held their London meetings in the room of the Society of Arts; but this year they could not do so, owing to previous arrangements having been made, and an application was sent to the Council of the Institution of Civil Engineers, which met with an immediate response. Their thanks were especially due to Mr. James Forrest, the Secretary of the Institution, for his kindness and courtesy, and he (the President) had much pleasure in moving—"That the best thanks of the Association be given to the Council of the Institution of Civil Engineers, and to Mr. Forrest, the Secretary, for their great kindness and courtesy on this occasion."

Mr. R. O. PATERSON seconded the motion, which was carried unanimously.

A vote of thanks having—on the motion of the PRESIDENT,

seconded by Mr. W. J. Warner—been accorded to Mr. King for his services to the Association, in connection with the report of the proceedings,

Mr. R. Morton proposed a vote of thanks to the Acting President, Mr. Charles Hunt, for his conduct in the chair during the meetings, saying it did not require any words of his to commend the resolution to all the members. They had listened with very great pleasure to his opening address, and he must say that he did so with peculiar pleasure, having been associated with Mr. Hunt for a number of years. He had watched his progress onwards with great satisfaction, until, within the last half hour, he had been elected President of the Association. He should like also to say that he thought his conduct in the chair had had a great deal to do with the harmony which had prevailed throughout. They had had some excellent papers, and looking back over the meetings of the Association from its commencement, he did not remember one when they had had a better class of papers read, or more interesting or valuable discussions upon them.

Mr. J. Annan (Wolverhampton) said he should much like to have the pleasure of seconding the proposition. Mr. Hunt belonged to the South, but he had come amongst them in the North, and, being his nearest neighbour, he must say they could not have sent a man better suited to them. The gas managers in the Midlands wanted some one of genial disposition, and Mr. Hunt had brought them all together into one focus, and made them acquainted with one another in a degree which never existed before he came to them. If he made as good a President of the Association as he had for the Midland Association, he (Mr. Annan) could only say they had done very well in electing him.

The motion was carried by acclamation, and

The President, in acknowledging the vote, said he was much obliged to the proposer and seconder for their kind observations. It was with considerable reluctance that he consented to act on this occasion, but he felt in doing so he was only performing a duty which would be expected of any of the members under similar circumstances, and with their approbation he was more than satisfied. He concluded by proposing a vote of thanks to their esteemed Secretary, Mr. Bennett, who, he said, was hardly recovered from an illness from which he had suffered for a considerable time; but, notwithstanding this, he had thrown himself into the work of the meeting with an energy which had not been surpassed on any former occasion.

Mr. Mead, as a very old friend of Mr. Bennett's, said he had much pleasure in seconding the proposition. Mr. Bennett had worked industriously and well for the interests of the Association from its foundation, and it was only due to him to thank him sincerely for his services, and to say that they hoped to see him fully restored to health as soon as possible, and that they might see him many more times at their annual meetings.

The resolution having been carried unanimously,

Mr. Bennett, in reply, said he had to thank the President very heartily for the kind allusions he had made to him in his opening address, and also for the remarks which had just fallen from him, as well as from Mr. Mead. To the members generally he had to offer his sincere thanks for the manner in which they had received those remarks. He could assure them it had afforded him very great pleasure, and an unexpected pleasure, in fact, to be able to meet them on this occasion.

The proceedings of the general meeting then terminated.

Annual Dinner.

In the evening the Annual Dinner of the members was served at the Cannon Street Hotel, and there was a very large gathering on the occasion. The President occupied the chair, and was supported on the right by Mr. William Woodall, M.P., and on the left by the Secretary, Mr. W. H. Bennett. The vice-chairs were occupied by Messrs. R. O. Paterson, Alfred Williams, and R. Harris. The following is the list of the Stewards:—Messrs. R. O. Paterson, T. Newbigging, J. Hepworth, W. H. Bennett, W. Carr, R. Harris, H. Woodall, J. West, W. Sugg, and P. Simpson. At the conclusion of the dinner, the President, in very happily-chosen language, proposed the toasts of "The Queen;" "The Prince and Princess of Wales and Members of the Royal Family;" and "The Army, Navy, and Auxiliary Forces." To the last toast Colonel Cowen responded. The toast of the evening—"Success to the British Association of Gas Managers"—was (in the absence of Mr. R. H. Jones, J.P.) entrusted to Mr. George Livesey, and replied to by the President; who, in turn, proposed "Our Guests." Mr. W. Woodall, M.P., and M. Aertz, of the Brussels Municipal Gas-Works, responded. The remaining toasts were—"The President Elect," proposed by Mr. R. P. Spice (in the absence of Mr. H. P. Stephenson); "The Past-Presidents," proposed by Mr. T. Newbigging, and responded to by Mr. J. Douglas (in the absence of Mr. E. Goddard, J.P.); "The Vice-Presidents," proposed by Mr. F. W. Hartley, and responded to by Mr. R. O. Paterson and Mr. R. Harris—Mr. G. W. Stevenson being absent; "The Committee," proposed by Mr. Magnus Ohren, and responded to by Mr. J. Hepworth; "Prosperity to the Benevolent Fund of the British Association of Gas Managers," proposed by Mr. Corbet Woodall, and responded to by Mr. W. J. Warner; "The Secretary," proposed by the President, and responded to by Mr. W. H. Bennett; "The Scottish and Provincial Associations of Gas Managers," proposed by Mr. G. Livesey, and responded to by Mr. J. M'Gilchrist and Mr. W. Carr; "The Press," proposed by Mr. C. Sellers, of York, and responded to by Mr. W. King; and "The Stewards," proposed by the President, and responded to by Mr. W. Sugg, whose name was specially connected with the toast, in consequence of his having taken upon himself the providing of the musical part of the programme. The efficiency with which this was carried out gave great satisfaction, and added much to the enjoyment of the evening.

Thursday, June 10.

At ten o'clock the members assembled on board the *Alexandra* steamboat, and were taken to Beckton, where an opportunity was afforded them of inspecting the whole of the works of the Chartered Gas Company, especial attention being directed to the recently-erected plant for the treatment of residual products. A more extended notice of this visit appears elsewhere; suffice it here to say, that the visitors were met on the pier by Mr. F. J. Evans—representing the Directors of the Company—Mr. G. C. Trewby, the Resident Engineer, and Mr. V. Wyatt, the Constructing Engineer, by whom they were courteously conducted through the works.

LECTURE ON THE PAST, PRESENT, AND FUTURE OF COAL TAR,

By GREVILLE WILLIAMS, Esq., F.R.S., &c.

DELIVERED TUESDAY EVENING, JUNE 8, 1880.

Mr. President and Gentlemen,—I have accepted with the greatest pleasure the invitation with which I have been honoured by your Committee to deliver before you a lecture on the Past, Present, and Future of Coal Tar. The subject is so vast that it will be evident to you at once that each department will have to be treated with brevity, and my whole care will be to prevent that brevity from causing indistinctness or confusion. My hope is that what I have to say will at least present a sharp clear outline, and with this intention I will define at stating what I mean by the Past, Present, and Future of Coal Tar. By the Past, I mean the history of coal tar previous to the great discovery of the aniline dyes made by Mr. Perkin. By the Present, I mean the discoveries made from that time until now; although I am compelled to include one or two observations of older date. In speaking of the Future of coal tar, I propose to call your attention to some of the ingredients of that substance, which, although of perfectly definite chemical constitution, have not yet been utilized, and are, in fact, thrown away.

In pursuance of this arrangement, I will ask you to just glance with me at the earlier researches which were made long before it was ever dreamed that coal tar would attain its present enormous and ever-increasing importance.

I think it may safely be said that the first cardinal discovery connected with coal tar was made in 1820, when Garden discovered naphthaline in coal-tar oil; and yet naphthaline was destined to be one of the last of the coal-tar hydrocarbons to be utilized. Even so late as 1866, when I wrote the article on "Naphthaline" for Watts's "Chemical Dictionary," I remarked that great efforts had been made to find a use for it, but that none had been entirely successful, although lampblack was sometimes prepared from it by condensing the dense smoke which burning naphthaline evolves. I also said that efforts had vainly been made up to that time to prepare fast colours from it; but I also added that there was no doubt whatever that in a few years, perhaps months, the difficulties in utilizing naphthaline would be overcome. It needs not to be said that this prophecy (which required no great powers of prevision) has now been amply verified, as I shall show you later on that the most superb colours are now produced from it; and, as I believe its uses will soon become greatly extended, and consequently its commercial value increased in

proportion, I strongly recommend you no longer to regard as valueless the deposits you may meet with.

The next great discovery to that of naphthaline was made five years later—namely, in 1825—when the illustrious Faraday discovered benzole, or, as we now term it when pure, benzene. He found it in the liquids produced by the compression of oil gas, but it is also formed in a great number of chemical reactions. I shall have more to say about it presently. Seven years later—that is, in 1832—Dumas and Laurent discovered anthracene, which at one time was called paranaphthaline. For nearly forty years it remained a mere chemical curiosity; but now it is second in importance to none of the products of coal tar. In the same year that Dumas and Laurent discovered anthracene, Reichenbach discovered in wood tar a substance which he called creosote; and, two years after—namely, in 1834—Runge discovered carbolic acid, which is known also by the names phenol, phenic acid, and coal-tar creosote. The wood-tar creosote and the coal-tar creosote were for a long time considered as the same substance, but they are now known to be specifically distinct. In the same year that Runge discovered carbolic acid he also found aniline to exist in coal tar; the quantity is, however, so small that it cannot be profitably extracted, and that is why we always prepare it from benzene. The actual *discovery* of aniline was, however, made by Unverdorben, as I shall show presently.

The year 1834 was, indeed, a fruitful one for the chemistry of coal tar; for, in addition to his other discoveries, Runge obtained the first colour reaction from coal tar, and this discovery was made in a very curious manner. You are all aware that one of the principal characteristics of ammonia is the fact that it gives white fumes when brought near a rod dipped into hydrochloric acid. Now Runge (who may be considered the father of the chemistry of coal tar) happened on one occasion to prepare some oils by distilling the tar, and he was desirous of ascertaining whether these oils contained any ammonia. A glass rod not being at hand, he dipped a slip of deal wood into hydrochloric acid, and held it over the oil, when it gave white fumes indicative of the presence of ammonia or of volatile organic bases; but, to his surprise, the part of the wood which had been wetted with the hydrochloric acid turned to a deep crimson colour. This reaction being unique, he knew at once that he had discovered a new and remarkable substance, and he gave it the name of pyrrol. Great efforts were made by himself and other chemists to separate this substance in a state of purity, but all failed. When, as a very young man, I entered the University of Glasgow, my lamented friend Professor Anderson having undertaken to isolate pyrrol, he confided the practical details of the work to me; and certainly few chemical pupils ever had a more interesting subject to work upon. It is enough here to say that the investigation was completely successful. Previously it had always been supposed that pyrrol was a gas possessing a most repulsive odour; but it turned out that instead of being a gas it was a liquid boiling at 133° C., its formula being C_4H_5N, and, when perfectly pure, possessing a delightful fragrance somewhat resembling that of chloroform.

I have here a few drops of the very first specimen of pyrrol ever prepared in a perfectly pure state, and I believe that it is now the only specimen in the world of the first pure preparation; but, small as this quantity is, it is enough to make many thousands of experiments which show its wonderful property of colouring fir-wood. I have tried repeatedly to estimate the minimum quantity necessary for the reaction; but to express this quantity we should have to use numbers like those used by astronomers to estimate planetary distances. I need hardly say that to make an experiment with so small a quantity of so precious a specimen is a task more fitted for the laboratory than the lecture-table; but I trust I shall succeed in making you all see it. Of course, if I used a pyrrol artificially prepared, I could have made the experiment on a larger scale; but I venture to hope that you would prefer to see this particular specimen. I have here a small slip of fir-wood. I shall just touch its point with pyrrol, and hang it in this glass with the aid of a card. I now touch another slip of wood with hydrochloric acid, and hang it by the side of the other slip, taking care that they do not touch. Now, although pyrrol boils at 133° C., and is, therefore, by no means a very volatile substance, the second slip (if the experiment be successful) will soon acquire a rich crimson colour. As (although pyrrol can now be made artificially) you will never again see the experiment made with the first specimen ever prepared, I hope you will kindly forgive me for taking up so much of your time with it, but I confess I never see it without thinking of the past history of coal tar; of Runge, who was the first to see the reaction; and of Anderson, whose investigation of pyrrol marks one of the great eras in organic chemistry.

Runge, I ought to tell you, when he saw this reaction, prophesied that one day other beautiful and useful colours would be made from coal tar; but, unfortunately, he did not live to see its fulfilment; and, equally unfortunately, the peculiarities of pyrrol have hitherto prevented it from being anything more than a chemical curiosity. However, the resources of Science are unlimited, and this reproach will one day be wiped away.

Three years after the discovery of pyrrol—that is to say, in 1837—Pelletier and Walter discovered toluene in the oils produced by the distillation of resin, and this discovery was only secondary in importance to that of benzene. It is scarcely necessary, I am sure, to remind you that the coal-tar colours are not contained, as such, in tar; but it is a remarkable fact that to this day there are many persons, even among those whose employments would lead one to suppose that they have at least some knowledge of organic chemistry, who believe that the colours on the table before me are extracted from coal tar. I even lately heard a person say, "Oh, I have often seen the coal-tar colours in the tar itself; for when a drop of tar falls upon water you see the most beautiful tints as it spreads out." I had some little difficulty in explaining to my friend that the colours he saw were not the coal-tar colours, but arose from the decomposition of light, in exactly the same way as we see in the soap-bubble and the opal.

I have now given you a strictly chronological sketch of the history of the discovery of a few of the principal ingredients of coal tar. It is, of course, only a sketch; but I have endeavoured to make it show the more salient features—the landmarks, as it were, of the more important discoveries which have led to the present wonderful development of this branch of industry; and I only hope that, in my endeavours to give you a sharp and definite outline, I have not trespassed too much on your patience.

At this point I must somewhat modify my programme; and, paying less attention to chronology, consider the steps by which the substances we have previously spoken of have become utilized. Let us, therefore, return to benzene, or benzole, as the crude article of commerce is usually termed. A partially purified product, containing, I believe, about 30 per cent. of pure benzene, is familiarly known in domestic economy under the name of "benzine-collas," and is used for cleaning gloves and removing grease. Its formula is C_6H_6, and its vapour is nearly three times heavier than air. I hope to be able to show you this heaviness by an experiment. I heat a small disc of copper over the spirit-lamp. I then place it at the bottom of a beaker, which contains a few folds of paper, to prevent the heat of the disc from causing fracture. I then pour a few drops of the hydrocarbon upon it. The heat will cause it to boil, and thus convert it into vapour. I then pour this vapour, just as if it were a liquid, into a second glass, taking care that no liquid accompanies it. Although apparently empty, you will see that on applying a light it inflames. Now, if the vapour of the benzene had not been very heavy, you will easily perceive that this experiment would have been impossible.

The great German chemist Mitscherlich found that benzene could be prepared in a very pure state from benzoic acid by distilling its lime salt; but it was reserved for Hofmann and his pupil, C. B. Mansfield, to show that the true source for the production of benzene on the large scale was coal tar. Mansfield devoted the remainder of his life to the production of benzene on the large scale. Unhappily, however, his enthusiasm for discovery led to his death; for a small experimental still, with which he was working, catching fire, he endeavoured to remove it in order to prevent the destruction of the building; and while doing so he became covered with the blazing liquid, and perished miserably; thus adding his name, like Gehlen and Scheele, to the sacred list of "Martyrs to Science."

The inflammability of benzene is such that it will even burn on water. There are many substances which possess this property, and even some which burn on mere contact with water. Thus, if I throw a scrap of the metal potassium on water, you see that it instantly inflames. If I now vary the experiment a little, by pouring some benzene on the water, and then throw a scrap of potassium in, you will see that the potassium inflames, and sets the hydrocarbon on fire. This property of benzene and other hydrocarbons to burn on water, and of potassium to inflame on contact with it, has even been proposed for use in naval warfare; I trust, however, we shall not live to see the time when such satanic means of destruction will be resorted to. Benzene boils at 80·8° C., or

178° Fahr., and at 0° C., or 32° Fahr., it freezes into a beautiful mass of colourless crystals.

In order to produce colours from benzene, the next step is to convert it into nitrobenzene. This is effected by treating benzene with concentrated nitric acid, in accordance with the equation—

$$C_6H_6 + HNO_3 = C_6H_5NO_2 + H_2O.$$

It is, therefore, in chemical parlance nitrobenzene, or benzene in which an atom of H is replaced by nitryl or nitric-peroxide. Nitrobenzene (or, as it is sometimes called in commerce, essence or oil of mirbane) is a heavy oily liquid, of a specific gravity of 1·1866, having a fragrant odour almost exactly like that of bitter almond oil. It is extensively used for perfuming the common kinds of scented soap; but it is somewhat poisonous.

This production of nitrobenzene is only one more step towards the preparation of the first of the coal-tar colours; so you will see that the beautiful colours upon the table are not obtained without much labour; and, indeed, with some of them there are thirty or forty operations to be gone through, some of them requiring very delicate manipulation, before the colours are obtained.

The next step is a most important one; this is the conversion of nitrobenzene into aniline, and it is to the discovery that aniline can be produed in almost any quantities from the benzene of coal tar that we are indebted for an apparently endless number of colours, having not only every tint seen in the rainbow, but many shades never before seen by man. To convert nitrobenzene into aniline, the nitro-compound is treated in large iron cylinders with iron borings and acetic acid. The change takes place in accordance with the equation—

$$\underbrace{C_6H_5NO_2}_{\text{Nitrobenzene.}} + 6FeO + H_2O = \underbrace{C_6H_7N}_{\text{Aniline.}} + 3Fe_2O_3$$

This reaction was discovered by M. Béchamp in the course of a purely scientific research. If he had known the enormous commercial importance it was destined to acquire, and protected it, his patent would have been one of the most valuable ever taken out. Be pleased to remember that this discovery of M. Béchamp's was not the discovery of aniline itself, but of a new mode of preparing it. Aniline was really discovered, as I have said, by Unverdorben in 1826; he obtained it by distilling indigo, and I can well recollect the time when an ounce or two, prepared in this manner, would be preserved in chemical laboratories as precious specimens. Unverdorben called what he had found in this manner—crystalline.

When Runge found traces of aniline in coal tar, he did not know that the substance he had found was the same as the crystalline of Unverdorben; all he knew was that coal-tar oils contained something which coloured fir-wood wetted with hydrochloric acid a deep yellow. He also found that aniline in solution in water turned a dark purple with a solution of chloride of lime. This last reaction is remarkable, as chloride of lime, or bleaching powder, generally destroys colours instead of producing them, as we shall see when we come to magenta. Now Runge concluded from what he had observed that the substance which gave a yellow with fir-wood and hydrochloric acid, and a purple with bleaching liquid, was a new substance, and he called it kyanol. It was reserved for Dr. Hofmann to discover that the crystalline of Unverdorben, the kyanol of Runge, and the aniline of modern chemists, were, in fact, the same substance.

Here is a specimen of pure aniline. It is an oily liquid boiling at 182° C., or 359·6 Fahr. Allow me to repeat myself a little, and to ask you to remember that coal tar itself contains only mere traces of aniline, and that it is never extracted from it directly, but is always prepared from the benzene of coal tar, as yielding infinitely more than could be prepared in any other way.

And now, having given you the history of this wonderfully prolific alkaloid, the parent of the colours you see on the table, and directly or indirectly of many others, we come to the history of the first colour which it yielded that was of any commercial value. Mr. William Perkin had the idea that quinine could be prepared from aniline; but his experiments not succeeding, they drifted into other channels, and the idea struck him that the purple I showed you as being produced when chloride of lime is added to aniline could be fixed, and used as a dye. While at work on the subject, he dissolved aniline in sulphuric acid, and added bichromate of potassium to the solution. In time a dirty-looking precipitate fell down, he poured a little alcohol on the precipitate, a purple dissolved out. He boiled the feather of his quill pen in the solution, and it became dyed with a purple infinitely more brilliant than had ever been seen before. Mr. Perkin then made this colour on the large scale; it met with an almost unparalleled success, and thus by his own unaided genius he became the founder of the vast industry now known as the Aniline Colour Trade, which, in its turn, has so immensely raised the value of coal tar.

Magenta.—I need hardly say that the revolution in colours produced by this discovery of Mr. Perkin's purple (or mauve, as he termed it) could not fail to set many chemists at work in the hope of discovering other colours from aniline. The next step was made by M. Verguin, who, by boiling aniline with anhydrous tetrachloride of tin, obtained a superb crimson, which as much eclipsed the old crimsons as the mauve eclipsed the old violets. This crimson is now known as magenta. Immediately numerous patents were taken out for new processes for making it; but that of Mr. Medlock, which consisted in treating aniline with arsenic acid, superseded all others. It was sold to a firm of manufacturing chemists, who greatly improved the process of purification, and made an enormous fortune by it. Now, 100 lbs. of coal yield about 5 lbs. of tar; this tar yields about 2 oz. of benzene, which in their turn yield about 1040 grains of aniline (say 2¼ oz. avoirdupois), and this aniline gives 207 grains of magenta pure and crystalline. This will dye 8 lbs. of wool a full deep shade, or would print 207 yards of calico of a medium closeness and depth of pattern; so that each grain of magenta will print one yard of calico.

The magenta of commerce is a salt, a hydrochlorate of what is called rosaniline. This rosaniline is a colourless base; I have here a solution of it. I add acetic acid to it, and you see that the colour is instantly developed. The tinctorial or colouring power of magenta is so enormous that if a piece of paper be simply dusted with it, so as to leave an imperceptible trace of the powder on it, it will become dyed if moistened with alcohol. A solution containing only a millionth part of magenta is distinctly red. But although magenta has such great tinctorial power, it is easily destroyed by a minute quantity of solution of bleaching powder. The colour that magenta gives to silk is very brilliant and beautiful, but it requires a very correct taste in dress or decoration so to use it as to avoid vulgarity. By daylight it is a rich crimson, but by gaslight it appears almost scarlet. This difference in shade is easily shown, you see, by the aid of burning magnesium.

Blues from Magenta.—Now although magenta is a finished product, it is also the raw material for the production of various other colours. If boiled with aniline under proper conditions, it forms beautiful blues and violets. The violets made in this manner are falling into disuse; but the blues made from magenta are still produced on an enormous scale. There are a vast number of them of different shades and qualities, but there is one whose properties are so remarkable that I shall show you an experiment with it which illustrates its chief peculiarity. It is what is called an alkaline blue—that is, it is dyed in an alkaline solution. Now, an alkaline solution of this blue is colourless, and the dyed fabric is also almost colourless; but when the wool or silk so dyed is dipped into a weak acid the colour instantly appears. The blue dyed in this manner has the valuable property of not rubbing off—that is, if rubbed upon a white surface, the latter does not become blued. It is proper to state that this blue was one of the many discoveries of Mr. Nicholson.

Greens from Magenta.—By heating magenta in its colourless or basic condition with iodide of methyl, it is first converted into a violet, and finally into a very lovely green, which has the property of appearing more beautiful by gaslight than in the daytime. Several other greens of more or less similar character are now made from methylaniline violet, and by the action of benzyl trichloride on dimethylaniline. The tinctorial power of this green will be seen by dusting a little on paper, and pouring alcohol on it. I now come to the

Dimethylaniline Violet.—By treating aniline with chloride of methyl under pressure we obtain dimethylaniline, and by mixing the latter with sand or common salt and nitrate or chloride of copper and acetic acid a mass is obtained, which is spread on copper trays in layers 3 or 4 inches thick. If these layers are kept in a room at a temperature of from 60° to 90° C. they harden, and assume a metallic appearance. When the maximum amount of violet is formed, which is easily ascertained in practice, the violet is extracted by water. The bluer shades are obtained by the action of chloride of benzyl on the base of the violet. These violets are now universally employed for all the richest shades on wool, cotton, or silk. Here is a piece of silk dyed with dimethylaniline violet. You are all aware that purples and violets appear much redder by artificial light than by daylight. I will now

burn a piece of magnesium ribbon, which yields a light as pure as that of the sun, and you will see how much bluer it appears.

I have no time to enter into the theory of the constitution of these colours, or of the aromatic series, as to do so would require more time than I can devote to the whole of this lecture. Those who desire information on this most interesting subject will do well to study the Supplement to Watts's "Chemical Dictionary," and the *Berichte* of the Chemical Society of Berlin.

Eosine.—The beautiful pink colour called eosine is produced from benzene by a long and somewhat complex process. The colour on silk or wool is a beautiful pink, and it makes the most brilliant of all red inks; but it is, unfortunately, rather fugitive.

Azo-Compounds.—The azo-compounds may be said especially to represent the Present of the coal-tar colours, as it is to them that the attention of modern chemists is particularly directed. It is to the admirable researches of Griess that the great progress in this direction is mainly due. An "azo-compound," in its most modern sense, may be defined as one in which one atom of nitrogen replaces one of hydrogen.

When nitro-benzene is treated at a boiling heat with nitric acid we obtain meta-dinitro-benzene, and this by reduction with iron and hydrochloric acid gives what used to be called phenylene-diamine, but is now known as diamido-benzene; and this substance in solution, when treated with nitrite of sodium and hydrochloric acid, yields triamido-azobenzene, or Bismarck brown. This colour, which is now made on a very large scale, is a valuable and fast colour. The quantities of this coal-tar product now used may be judged from the fact that one firm in three years made 160 tons! I now come to

Chrysoidine.—This colour was discovered by Dr. Witt, in the endeavour to obtain a diamido-azobenzene, as, for excellent reasons, he expected it to prove a valuable colour. Chrysoidine crystallizes beautifully, as you will see by this specimen. It gives a very fine colour on wool, of a beautiful orange yellow shade, such as you see in this "swatch." [The word "swatch" is used by dyers for any piece of silk, wool, or other material used to try the quality of any colour either by dyeing or printing.]

Tropæolines.—The tropæolines are a further development of the azo-compounds, and can be obtained of all shades, from the palest orange to the deepest scarlet. Dr. Witt's tropæoline, OO, is one of the most beautiful of all the members of the series, and appears quite resplendent by the light of burning magnesium.

Naphthaline Colours.—Many beautiful colours are now prepared from naphthaline. I have only time to show you one of them—namely, this naphthaline scarlet, which is, I think, quite sufficient to prove that the once despised naphthaline, so detested by gas managers (from the way in which it stops up their pipes), has now an important place among the colour-yielding products of coal tar.

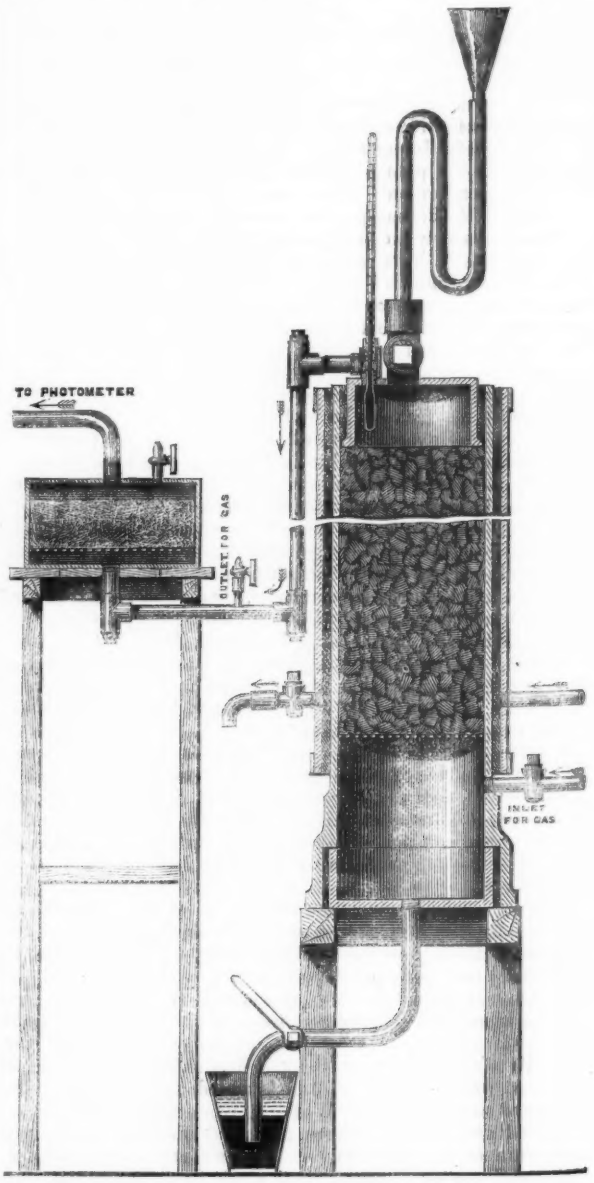
Diphenylamine Blue.—My friend M. Charles Girard, by heating aniline with hydrochloride of aniline, succeeded in producing a new alkaloid called diphenylamine. By heating it with oxalic acid it yields a superb blue, which, when treated with sulphuric acid, yields a sulphonate having the character of an alkaline or Nicholson blue. Seen by the aid of burning magnesium, its shade is very beautiful.

Picric Acid.—Among the many constituents of coal tar is a substance called at various times by the names of phenol, phenic acid, and carbolic acid. It is another of the many gifts to science of the German chemist Runge. It is now so invaluable as a disinfectant and antiseptic that surgeons and physicians would be at their wits end without it. As a dressing after surgical operations, especially on the battle-field, it acts like a charm; and inhaled with steam, in even the worst cases of sore-throat, its effects are truly wonderful. But it is not with its medicinal effects that we have to do this evening. When treated with nitric acid it yields a substance to which numerous names have been given at various times. We will simply call it picric acid. It dyes silk a delicate sulphur yellow, which is very permanent. It is a substance which requires to be used with caution, as its salts are very explosive, as you will see when I heat a little picrate of potassium on a spatula. It has been proposed by some French artillerists to use it in warfare, but it has been rejected as uncertain and treacherous.

Anthracene.—When coal tar is distilled, and the still is at a very high temperature—too high, indeed, for the mercurial thermometer to register—a substance comes over in a very impure state, called anthracene. It remained a mere scientific curiosity until two celebrated German chemists, Graebe and Liebermann, made the brilliant discovery that anthracene could be converted into alizarine, the principal colouring matter of the madder-root. It is this substance with which the famous Turkey red dye (so well known for its fastness and beauty) has been prepared almost time out of mind. I have here a specimen of cotton dyed with alizarine from coal tar.

The alchemists called the worthless residues contained in their alembics a *caput mortuum;* but here we have the *caput mortuum* of a *caput mortuum*—the residue of a residue—and yet at the bidding of Science the last residues of the distillation of coal tar, known of old by the name of dead oils, yield the raw material for the production of the brilliant colouring matter of a plant.

So much, gentlemen, for such of the colouring matters of coal tar as I have had time to describe. I have done my best to be brief, but I cannot help feeling some alarm lest I should have wearied you. I will, therefore, turn for a moment to a question in which you are all, I believe, deeply interested—namely, the effect of the contact of tar upon the illuminating power of coal gas. The subject has been ably treated by Mr. Bowditch, Mr. Livesey, Mr. Patterson, and others; and I think it has been pretty generally agreed that the contact of tar at ordinary temperatures deteriorates the illuminating power of gas; but I am not aware of any photometric experiments showing the exact amount of deterioration taking place in an apparatus of a given size. My friend Mr. Morton requested me to determine this point, and was kind enough to give me every possible assistance in making the experiments. If they have any value, the merit belongs to him; but for any defects or want of completeness, I take the entire respon-



Apparatus for Effecting the Contact of Coal Gas with Tar.

sibility. I may, however, say that the investigation is still proceeding.

In order to make the results strictly comparable, an experimental gasholder was filled before each series of observations. To effect contact of the gas with the tar, an apparatus 7 feet in height and 9 inches in diameter was used, which is accurately represented in the diagram, on a scale of 1 inch to the foot. The tower was filled with clinkers saturated with tar, and the gas was passed through at the rate of 5 feet per hour. The tower was surrounded with a jacket, into which steam could be passed to increase the temperature; but it was not used in the experiments I am about to describe. The temperature of the gas was estimated by an accurate thermometer placed at the exit from the column. The lowest temperature recorded was 50°, the highest 60° Fahr. Before reaching the photometer the gas passed through a purifier containing oxide of iron, to intercept any sulphuretted hydrogen with which it might have become contaminated during its contact with the tar. At the upper part of the column a syphon was placed to enable the tar to be poured into the column without permitting the entrance of air. At the lower part of the column an exit-tube was placed to allow of the escape of the excess of tar. This tube was sealed by dipping into tar covered with water. Precautions were, of course, taken that every trace of air was expelled before the gas was tested.

In the first series of experiments, the gas before being passed over the tar gave, as a mean of 50 closely-agreeing experiments, an illuminating power of 16·24 candles. After passing over the tar at the same rate, the gas gave, as a mean of 100 photometric observations, an illuminating power of 14·39 candles. This indicates a loss equal to 1·85 candles. In a second series of trials, a fresh sample of gas before contact with the tar gave an illuminating power equal to 15·19 candles, and after contact with the tar 13·01 candles; the loss being equal to 2·18 candles. As the difference between the first and second series of experiments is only 0·3 of a candle, it may, with perfect safety, be said that, under the circumstances indicated, the gas is injured to the extent of 2 candles. The photometric observations were made with Mr. Methven's standard light, which I found admirably suited for experiments of this kind.

Allow me to return to the coal tar colours for a moment, as I wish to remove an absurd impression which prevails among some persons that all aniline dyes are poisonous, and contain arsenic. It is true that magenta, as prepared by Medlock's process, contains traces of arsenic, but certainly not enough to do the slightest harm to any one wearing any article dyed with the colour. All the other dyes are perfectly free from arsenic, and Mr. Anthony Nesbit has fed rabbits for weeks together upon food containing most of the dyes I have mentioned to-night, and, strange to say, their general health, if one may judge from their appetite and condition, was not in the slightest degree impaired. It is true that some pigments—that is, paints, not dyes—like orpiment and emerald green, contain large quantities of arsenic. Orpiment should never be used, as it gradually fades, and the deplorable way in which Sir Joshua Reynolds's pictures have deteriorated is partly due to the use of orpiment and carmine; this last colour, although perfectly harmless, becoming grey in the course of time.

Future of Coal Tar.—Permit me, in conclusion, to say a few words on the Future of Coal Tar. It may confidently be said that none of the products of coal tar are useless. A well-known chemist, several years ago, in a work which in many respects showed great cleverness, was unwise enough to reproach chemists for the enormous labour which they had bestowed on what he called so useless a substance as aniline. He, however, lived to see it become one of the most valuable substances in existence. It is true that the leucoline and pyridine series have not as yet been utilized; but to doubt that they will one day yield valuable derivatives would be to neglect all the teachings of our glorious science. Nothing exists in vain, and the chemists who, for the sake of pure science, study the physical and chemical properties of new and as yet useless substances, are preparing the way for the practical man, who will one day be thankful to those pioneers who have smoothed the road, and made the advance into new realms comparatively easy. Although the leucoline series have not yet been utilized, I found a quarter of a century ago that its isomer, chinoline, by alternate treatment with iodide of methyl and oxide or sulphate of silver, yielded superb coloured reactions; and doubtless, by suitable processes, the leucoline series will be made to afford valuable products.

I found also that chinoline treated with iodide of amyl, and then with caustic alkalies, yielded the superb blue colouring matter cyanine. This colour, from its peculiar constitution, forms quite a new departure in organic chemistry, and recent researches show it to be closely allied to our subject; as, from the observations of Ballo and Dewar, there seems to be little doubt that chinoline at times, and perhaps often, accompanies or replaces leucoline in coal tar.

There are also many other substances which have not yet been utilized, among which I may mention the solid hydrocarbons chrysene, retene, and pyrene. It needs no prophetic eye to see that, with the substances already known, there is room for an absolutely endless number of new combinations; and the Future of Coal Tar will be far more brilliant than the Past or the Present.

To me, gentlemen, coal tar, though "black," is "comely," and if I have failed to impart to you some of my own enthusiasm for it, the fault lies with me, and not with the subject, which I feel is worthy of treatment by a master-hand.

PAPERS READ.

(I.)
EXPERIMENTS ON THE THERMAL POWER OF GAS HEATING APPARATUS.

By Mr. T. Travers, of Cork.

In a paper which I had the privilege of reading before you two years since, your attention was called to the fact that gas cooking and heating stoves did not, as a rule, give the full thermal effect practically available from them. To us this is a matter of importance, as one of the points with which we have to contend is to demonstrate the economy of gaseous fuel. At present this can only be done when gas is consumed under the most favourable circumstances.

Manufacturers of gas cooking and heating apparatus are succeeding very well in making them attractive to the eye. Both in style and finish they are suitable to grace, in many instances, a well-furnished room; but to render them more popular, attention must be paid to the mode of developing the largest amount of heat from the smallest quantity of gas. What I purpose showing is that in the majority of instances this is not obtained, and it is desirable that additional pressure be put on the stove makers, so as to enable us to speak with more confidence to our consumers. As a kindred case in point, you are aware that some years ago gas burners then in use did not give the same amount of light per foot of gas as we now obtain. If the electric light did no other good than to rouse the burner makers to the sense of the injustice they were so long perpetrating on gas makers and gas consumers, by impeding the full development of the illuminating power, it has done good work. In like manner let us spur on the stove manufacturers to that which will certainly prove to be of mutual benefit.

In order to be able to recommend to the gas consumers of Cork the best and most economical apparatus, I made, during last year, some experiments, and from the results of them I think it will be seen that the apparatus in general use are capable of such improvements as will lead to better results. I am fully aware that the effect of any kind of fuel is much greater on theory than in practice. I have, therefore, made the experiments on a plain, practical method, such as may be applied to the doings of every-day life.

Intimately connected with this subject is that of the thermal power of gas of various qualities, and I commenced operations by making some tests under this head. I noticed that the results are not quite in accordance with some I have seen in the journals. The apparatus with which I operated was capable of carbonizing 30 cwt. of coal per day. I was, therefore, able to make a comparative calculation of the cost of the gas from coal of various qualities. The coal was Scotch cannel, Newcastle coal, and coal from South Wales. The points noted were—

The illuminating power.
The evaporating power of the gas.
The net cost of coal per 1000 feet of gas.

Coal.	Illuminating Power.	Water Evaporated.	Gas Consumed.
Cannel	24·0 candles	1 gallon	18·50 cubic feet.
„	22·0 „	1 „	19·75 „
„	20·0 „	1 „	20·50 „
Newcastle	16·5 „	1 „	21·75 „
„	14·5 „	1 „	22·00 „
„	13·5 „	1 „	22·50 „
South Wales	10·5 „	1 „	28·00 „
Do. do. and 20 per cent. cannel	14·0 „	1 „	23·50 „

Of course the thermal theoretical efficiency of the various descriptions of gas is far greater than the results which are given above.

On the average it will be found by the experiments that 16 lbs. of water were evaporated by 1 lb. of gas. Newcastle

coal gas, for example, of sp. gr. ·420 has an evaporative value equal to 22 times its weight. From the figures it will also be seen that the thermal power does not increase in the same ratio as the illuminating power, as some people suppose. The calculations I have made of the net cost of coal per 1000 feet of gas prove that a very cheap gas of low illuminating power can be produced for heating purposes, provided we were able permanently to enrich it at the consumers meters when used for illuminating purposes—an experiment worthy of the attention of the inventive portion of the profession.

Taking gas from Newcastle coal at 16 candles as a standard of the average gas at present supplied, and 750 as the thermal units per foot of gas, I made a series of experiments on the gas-stoves from the various makers. I took the stoves as they are delivered in the usual way to purchasers.

	Thermal Units per Cubic Foot of Gas.
No. 1.—Cooking stove fitted with a Bunsen burner formed by a ring of 1¼-inch wrought-iron pipe with jet holes 1 inch apart gave	244
No. 2.—Boiling stove, consisting of single burner 9 inches diameter, made of ¾-inch pipe, jets ¾-inch apart . .	260
No. 3.—Hotplate, consisting of three rings each 6 inches diameter, jets ½-inch apart	280
No. 4.—Like the above, rings 4 inches diameter	310
No. 5.—Cooker formed of bars of 1-inch wrought-iron pipe, jets ½-inch apart .	338
No. 6.—Concentric burner, consisting of a double row of rings one inside the other, 6 inches diameter . . .	390
No. 7.—Burner, same construction as above, but 4 inches diameter . . .	408
No. 8.—Solid flame burner	450
No. 9.—Wallace's burner adapted for domestic purposes	580

To the construction of this burner is due the higher return of work than from the others. It is on the principle that jets of fluid escaping from an orifice travel on in their original direction of motion a certain distance before they disperse. In this burner the gas is made to leap across a space, and in doing so it communicates a sort of gaseous friction to the air. Both then move in the same direction, but with a retarded motion; thus they become mixed in a chamber, from which they escape through a wire gauze, and they burn at a point of exit in the shape of solid flame, varying in diameter according to the size of the burner. Here we have a very powerful concentrated heat, developing a very large percentage of the calorific efficiency of the gas.

It is important to ascertain the reason of this. You are aware that in combustion for the purpose of artificial light, we have a very interesting arrangement of nature. The combination of oxygen with hydrogen causes powerful heat, and consequent expansion. Hence the particles of carbon are scattered freely through the heated hydrogen, and thus they remain for some time before their exit; and from their incandescence, diffused in all directions, we obtain beautiful light. But in the Bunsen burner the case is different. The oxygen is introduced in such quantities that there is not time to allow the carbon to radiate its light. It is at once converted into convected heat—that is, the transfer of heated air from one place to another moving in one direction—and thereby we obtain from this lightless flame intense heat. But note the difference—not hotter nor nearly so hot to a body exposed to its radiation, but very much hotter to a body plunged in the flame. It is by attention to this principle of convected heat that, for certain purposes, we obtain the best results from the Bunsen burner, while for other purposes radiated heat is more suitable.

Professor Tyndall very clearly illustrates the difference between the two. With ordinary gas-burners the convected heat generated is 80 per cent.; radiant heat, 16 per cent. In the Bunsen burner 96 per cent. is convected heat, and 4 per cent. radiant. Tyndall has found that radiation from a luminous gas-flame was 2⅓ times that from a non-luminous flame. Using an apparatus of an exceedingly sensitive precision, furnished with a dial index that noted the degrees of force, not of heat, the degree of force in a luminous flame was 30, and the radiation fell to a force of 12 the moment it became non-luminous. But by introducing solid matter the radiation originating in the hydrogen or non-luminous flame became so intense that a spiral of platinum wire plunged in the former brought up the index to 200. There was thereby generated an amount of radiant heat more than six times that of the luminous gas-flame, and more than thirty times that of the non-luminous one.

A few months since I had a practical illustration of the advantage for certain work of a luminous over a non-luminous flame, and one which will be found to apply in many similar cases. In a low-lying district we erected a stove from one of the best makers; but the day pressure was not sufficient, and the result was that the Bunsen burner, which formed the heating ring in the stove, frequently fired back, and was thereby a source of annoyance, and so retarded the efficiency of the range that the consumer became dissatisfied. To increase the pressure was out of the question. To meet the case if possible, I converted the non-luminous into a luminous flame, and since then we have had no firing back. The consumer is perfectly satisfied, both with the quality of the cooking and the convenience of the stove; and the consumption of gas is not increased by the alteration, for much of the heat that was before lost by convection is now converted into radiated heat. Bunsen burners, to be used for heat-giving in fire-places, are, to my mind, and for the reasons given above, a mistake; for, unless special arrangements are made, over 90 per cent. passes off in the shape of convected heat.

I think it is clear that there is here a wide field for the exercise of skill and ingenuity for such as are interested in this portion of our business. There is a practice, very strongly to be condemned—viz., the course pursued by some who attempt to fix heating stoves without making provision to carry off the products of combustion; and makers who recommend such ought to be made aware that they are thus displaying an ignorance of a very elementary portion of their business.

I am glad to find, in a paper read by Mr. Fletcher, of Warrington, before the Society of Arts a short time since, that he corroborates the experiments referred to in this paper. This is an illustration of the fact that two persons very often arrive at like results when pursuing the same subject quite independently of each other.

Discussion.

Mr. F. W. Hartley (London) said he was somewhat surprised at the low calorific effect obtained by Mr. Travers with a ring burner—only 244 units. Mr. Travers was somewhat hard on makers of stoves who, to a great extent, were forced to make cheap things to suit the public, who, as a rule, were indisposed to pay the prices required for good ones, and, indeed, in many cases, were incapable of using the best. He (Mr. Hartley) had for years been interested in the subject of the use of gas for heating purposes, and could say that the calorific power of London gas had not sensibly changed during the past seven years—indeed, he was sure it had not changed during a much longer time, but said seven years, as his records proved this. About Christmas last he was led, owing to interest re-excited in his mind by being engaged as a juror, both at the Birmingham and Nottingham gas apparatus exhibitions, to repeat old experiments, and make some, to him, new ones. He first sought to ascertain as nearly as possible, in a practical way, the total calorific power of ordinary coal gas, and having at Nottingham realized, with a very excellent water heater, 626 units, he borrowed a similar one from the maker, and from London gas realized in the water 612 thermal units. In addition, he noted the temperature of the casing of the heater and of the air, as well as of surrounding objects. Besides noting the temperature of the effluent gases, he also took means to ascertain their volume. When all these factors were taken into account, the calorific power of the gas was shown as 680. Mr. F. J. Evans a few years ago determined the power as 650 units, while Mr. Harcourt and some others fixed upon 700, which he believed to be very near the truth. The calorific power might be calculated from the composition of the gas; but the question arose, what was its composition? One authority some time since gave such a composition as indicated London gas to be of ·396 specific gravity, and its calorific power to be 695, while another more recently gave such a composition as indicated a specific gravity of nearly or quite ·500 (for common gas, be it understood), and a calorific power of 797. Both the calculations were subject to a small deduction for the effect of the presence of small percentages of carbonic acid, nitrogen, and oxygen in the gas. The gravity of the gas, as worked out from the last analysis, seemed to indicate that the analysis was wrong. He had found London gas as high as specific gravity ·430; but, as far as he had ascertained it, it was generally somewhat lower. If it were not now, unfortunately, a very common practice for vendors generally to put exaggerated statements before the public as

to the merits and powers of the articles to be sold—a practice for which vendors were not altogether to be blamed—he (Mr. Hartley) should be astonished at the audacity, arising, he thought, as much from want of knowledge as anything else, with which some makers gravely stated that their particular speciality developed from 50 to 100 per cent. more heat from coal gas than science showed to be possible. He must confess, however, that he was surprised that a gentleman of high skill and experience in the application of gas for heating purposes should make such a blunder as to state and to believe that he had "got in actual work 1 gallon of water boiled with an expenditure of 1½ cubic feet of gas." He said "blunder," for either the calorific values of gases, as determined by scientific men of the highest standing, and given in the best text-books, were fallacious, or Mr. Fletcher, of Warrington, must be wrong. The Manchester gas was richer than London gas, but he (Mr. Hartley) ventured to say with some confidence, it was far from being so much as 100 calorific units greater in power. Assuming for the sake of demonstration, that Manchester gas was of 800 units power, and what followed? One gallon, or 10 lbs. of water, raised through 152° (from 60° to 212° Fahr.) required 1520 units of heat, and if 1½ cubic feet only of gas sufficed, the calorific power of the gas would be equal to 1013 units per cubic foot, or at least 27 per cent. in excess of possibility. He believed Mr. Fletcher's statement to be in error to a much greater extent, for the water was said to have been boiled. Now as higher temperatures were reached with water, more heat went as it were to waste, the highest calorific power being manifested in ordinary heating when the water was kept under about 100° Fahr., and raised only through about 40° or 50° Fahr., because the water of combustion escaped as steam along with the generated gases at higher temperature, and this higher temperature operated to produce a more rapid draught of air over the vessel that contained the water which was being heated. The following, he said, represented a fair average of the results which he had obtained, and showed the values of the gas per cubic foot in raising water from 60° to 210° Fahr., in a tin kettle placed over a good air burner; the air and walls of the room being at 60° Fahr.:—

Water raised 18° F.;	Calorific power of	gas per	cubic	foot,	450
,, 44° ,,	,,	,,	,,	,,	440
,, 83° ,,	,,	,,	,,	,,	412
,, 121° ,,	,,	,,	,,	,,	403
,, 150° ,,	,,	,,	,,	,,	394

Hence the average power was only 87·55 per cent. of that first indicated, and such must always be the case. Sometimes in cold weather he had only realized from 74 to as low as 61 per cent. He thought it was hopeless to expect to realize in heating water more than 90 per cent. of the actual calorific power of any gas, however much apparatus might be improved. Now, 90 per cent. of 800 was 720, which divided by 152 (the difference between 60° and 212° Fahr.) gave 4·73 lbs. as the possible weight of water which might, by an extremely refined mode, be raised from 60° Fahr. to boiling point; this was equal to 7·09 lbs. instead of 10 lbs. for 1½ cubic feet of gas. Still, taking 90 per cent. as a practically possible maximum, and 700 as the power in units of common gas, there were 630 units, which were capable of raising 4·145 lbs. of water from 60° to 212° Fahr. At the present time, by the agency of the best kettles and burners in use, not more than about 2·66 lbs. of water were so raised in temperature. Most baths which were directly heated by burners below them rendered less than 400 units to the foot of gas burned, though he had found some in which the heat developed in the water had risen as high as 470 units; but, unfortunately, the economy had been accomplished at an enormous sacrifice of time. One bath, which was specially referred to, required about an hour and a quarter to raise 30 gallons of water from 60° to 100° Fahr.; while others, burning gas less effectively from a scientific point of view, did the same work in from 30 to 40 minutes. Water heaters, so called, also gave the highest calorific results when the water was raised only to about 100° Fahr., and through from 40° to about 60° Fahr. The heater which he had mentioned as yielding up to the flowing water 612 units per cubic foot of gas, was used under such favourable conditions as had been mentioned, the outflowing water being 102° Fahr.; but when with the same heater the water was raised to 182° Fahr. from 38° Fahr., the realized heat fell to 471 units. Again, when it was tried with the gas consumption very low, and the water only raised through 11° Fahr., the indicated heating power was 388 units, or about the same as was realized with an ordinary kettle. Truly these tests were very severe, but he mentioned them to show that it was only under certain conditions that the things called water heaters were greatly superior to other heating apparatuses. In his paper on "Cooking by Gas," which was read before the Association at the meeting in 1873, he said that, in his opinion, ovens of circulation, if he might call them so, were to be preferred to those which cooked by the heat of radiation. He was still of the same opinion; but in his investigations he had been struck with the beauty of many of the radiating stoves which were now being made, and with the admirable manner in which they did their work. It was not his intention to say one word in their disparagement, for they overbore a stupid prejudice which some of the public had against subjecting food, in the older types of cooker, to the products of combustion; but what he did regret was to see that so many makers should use air burners for radiating heat, in ignorance, it seemed, of the fact that the amount of heat radiated by the non-luminous flame of mixed gas and air was greatly less than that from a luminous flame burning the same quantity of gas. It must be admitted, however, that in cookers the difference was far less than when the burners were in the open, and for the reason that the burner was surmounted by a deflector, which became hot and radiated downwards part of the heat which it received from the burner beneath it; but this benefit was too often dearly purchased, for if the deflector were near enough to the burner to produce the best effect, then if the gas were turned the least degree too high, imperfect combustion ensued, with the evolution of an odour offensive to the nose, and of fumes highly irritating to the respiratory organs. In the course of the experiments which he made he used several small heat-radiating cookers. Some which he bought were fitted with air burners, and one with a circular jet burner. For the last he had an air burner made, and for the others jet burners, so that he could substitute in such a cooker either sort of burner for its opposite. Next he had some vessels of tin plate made, which closely fitted the ovens, and were each about 1 inch deep. These were protected at the bottom and front by a casing of wood, to prevent as much as possible any cooling effect from the air. They were also fitted with tubes, which served for the insertion of a registering thermometer, and also afforded room for the expansion of the measured quantity of water with which each vessel on every occasion was filled. These vessels were placed at the same distance below the burners in all cases, and at a little less distance than the cooking pan was intended to be. To complete the information, he used the vessels both with bright tinned surfaces and with the same surfaces blackened by the best of all blacks—namely, that deposited from gas burned smokily. The differences in heat absorption between bright surfaces and blackened surfaces ranged with the air burners in the proportion of 100 with the bright surface to 250 with the blackened surface, and with the luminous jet burner in the proportion of 100 to 246; while the proportion of heat absorbed by the bright surface heated by the air burner, as compared with the same heated by the jet burner, was as 100 to 131; the ratio with the blackened surface being 100 to 128. Taking the calorific value of the gas at 680, as determined by himself, the average of a number of experiments with blackened vessels gave 7·83 with the air burner, and 9·95 with the jet burner, as the percentages of heat realized in the radiant form. These quantities were almost incredibly small. However, Mr. Fryer and he agreed at Nottingham that it would be well to try certain reflector stoves, and that gentleman made a vessel of tin plate, blackened on its face, measuring 1 foot square, cased in wood, and of a capacity to contain exactly 1 gallon of water. This was placed vertically at a distance of 6 inches from the stoves which were tried. Taking Nottingham gas as capable of yielding 700 thermal units, the results he obtained worked out at 9·3 and 9·64 per cent. only. This by no means represented the effective heat power obtained in use. For in heating water by convection, as an old experiment showed, the top surface might be boiling while the lower part was cold, but the experiment served to show the relation between the kinds of burners. All such experiments gave correctly enough the ratio between certain burners or apparatuses, but by no means indicated their effective value in actual work, such value being greatly higher. The reason for the low indications was quite easy to understand, but it was difficult to devise means whereby to realize working effects. Reverting for a moment to cooking stoves—ovens of convection—he might say that he had sought to find some factor which should be a standard of economy. It was known that in most things with which gaseous or other fuel was used, the proportionate expenditure of fuel diminished as the power for work of the things increased. So it was with gas ovens; the larger they were the less gas per cubic foot of capacity

did they need, if properly constructed. He had observed that the ratio of consumption tended to be proportionate inversely to the cube root of the capacity, and he had little doubt that if all the stoves he tested had differed in no other respect than in size, such rule would be found very near the truth. Thus:—

Cubic Capacity of Oven. Feet.	Gas burned per Hour per Cubic Foot of Capacity.	Gas needed, as calculated by assumed Rule.
19·00	3·56	—
12·00	4·00	4·13
18·00	4·65	4·73
1·66	9·70	8·08

If some such standard could be established for each particular class of stove, it would facilitate the estimation of relative worth, and possibly save some things, which merited approval, from condemnation.

Mr. A. G. Vernon Harcourt said he hardly knew whether it fell sufficiently within the scope of the paper which had been read, but, seeing the title on the list, he thought he would like to describe a small apparatus for the application of the heating power of gas, which was often wanted, and which ought to be wanted more frequently—namely, the heating of a small conservatory during the winter, in order to keep out the frost. This was a very common need amongst householders in this country, and he was consulted by a friend of his as to how he could most conveniently manage it. He thought it could be most advantageously done with gas, because there would be less trouble; and, after thinking about it, he contrived a small and simple apparatus, which had stood the test successfully of the last two winters, which had been longer and more severe than English winters commonly were. The arrangement consisted of a little cupboard hollowed out lower than the level of the floor of the conservatory to be heated, in which a Bunsen burner was placed. This opened through a grating into the conservatory, so that any heat radiated was not lost, and immediately above the burner was placed an ordinary rain-water pipe, which was carried round the conservatory, and then out through the wall to a chimney, so that the whole of the heat produced by the gas, and the heat radiated from the tube, passed up through the grating into the conservatory, and was not lost. The products of combustion—carbonic acid, steam, nitrogen—along with the excess of air which entered the tube, passed all together round the conservatory, and out through the wall to a chimney carried a certain distance above the roof. The difference of temperature between the heated gas in the first portion of the tube, and the slight difference that still existed between the gas in the chimney and the outer air, was sufficient to secure a movement of the products of combustion throughout the pipe, and the burner drew very well, even on windy days. What he aimed at accomplishing was this—that as nearly as possible all the heat produced in the combustion of the gas should be utilized in the heating of the room. All one needed to secure was, that the whole of the heat produced where the gas was burning, and all the heat that went off in the process of combustion, except the very small quantity necessary to secure a draught, should be utilized. The pipe was very hot at first, but gradually, as in an ordinary air condenser, the temperature sank as the heat was given out in passing through the iron pipe, and the gaseous product as it issued from the chimney was scarcely warm to the hand. Therefore but a very small quantity of heat was lost. Whatever the absolute number of units produced by the combustion of gas, what one wanted to be sure of was that the least possible amount of that heat should escape; and when this had been done, all that was possible had been accomplished. The arrangement he had described was very simple. It was effective, and not costly. The labour was simply *nil*, since it was only necessary to turn on the tap when one wanted to light the burner, and turn it off when not wanted, whilst more or less gas could be burned, according as the temperature required was higher or lower.

Mr. A. H. Wood (Hastings) said that for ten years past he had warmed a greenhouse in a somewhat similar manner, and for eight or nine years he had a striking-pit in which there was a coil of 2-inch pipe laid horizontally in the bottom of the pit, with 9 or 10 inches of earth above, and under it a jet burning about 1 cubic foot of gas an hour. Nothing but the products of combustion were carried off by a pipe at the end, and this last spring he had taken out several pans of cuttings, every one of which had developed into a very nice plant.

The President said Mr. Harcourt had described a most simple and excellent method of heating greenhouses, such as was very much wanted. There was a wide field for the employment of gas in this direction, and he would only ask him whether he considered the upright pipe absolutely necessary, or whether it would not be sufficient to stop short without taking the pipe through the wall, trusting to the heat of the gas to produce the necessary draught.

Mr. Harcourt said it depended upon how far below the level of the conservatory it was possible to get. He had constructed more than one of these arrangements, and in his own house, where he could get down some 12 feet below the floor of the greenhouse without burrowing, and so had a longer pipe above the burner, he did not use the chimney, but simply allowed the products of combustion to issue at the level of the horizontal pipe. In the other case, where he had only a rise of something like 4 feet, he found he had hardly power enough, and therefore had to put on the extra chimney. He had omitted to point out that there was an arrangement at the lowest part of the iron pipe for letting the condensed and rather acid water produced in the combustion of the gas run out. It was necessary that this should be done, or else it would lie in the pipe, and cause corrosion.

Mr. Travers, in reply, said he was glad to find that his paper had led to such important communications as had been made by Mr. Hartley and Mr. Harcourt. Mr. Hartley seemed to doubt the fact of his having obtained only 240 units of heat from a ring burner; but such was the fact, for he had repeated the experiment several times. His object was simply to point out how much below the mark some of the stoves were, and hence the reason why there were so many complaints as to the excessive cost of gas when used for heating purposes. He heartily agreed with Mr. Hartley in his remarks with respect to the efficiency of gas-stoves.

Mr. Hartley said it was quite a mistake to suppose he had doubted Mr. Travers's statement; he had only expressed his surprise at the result.

EXHIBITION OF GAS APPARATUS AT COVENTRY.

A small but interesting exhibition of gas cooking and heating apparatus was held last week in the Corn Exchange, Coventry, under the auspices of the Coventry Gas Company. The exhibition was, in the main, similar to those which have of late been held in various parts of the country, and comprised samples of most of the appliances which have been devised for promoting the use of gas for domestic and other purposes. The building selected for the exhibition was exceptionally well suited to the purpose, as the large area available allowed of the exhibits being so arranged as to make an effective display, while sufficient space was at the same time afforded for their convenient examination by the visitors.

The articles to which the projectors of the exhibition desired specially to invite the attention of the inhabitants of Coventry—viz., the cooking and heating stoves—were furnished by the four best known makers; and of their exhibits it is quite unnecessary to speak at length, each firm having already an established reputation. It may, however, be said that down the centre of the building Messrs. Leoni had a very comprehensive show of their kitcheners in various sizes, and these were backed by a good assortment of jacketed gas cookers, exhibited by Messrs. Wright, which are found to be so economical in working; whilst against the walls on either side, Messrs. Billing had an array of their "Sun Dial," reflector, and *repoussé* work stoves, and Messrs. Hassall and Singleton showed some of their boiling stoves and their large Phœnix range. It will thus be seen that a very fair bid was made for the patronage of the visitors.

Most of the usual accompaniments of a gas apparatus exhibition were present in the shape of gas-heated baths, water-heaters, and gas-pressure regulators and burners; Mr. W. Sugg's improvements in the latter direction meeting the visitor on the very threshold, while his gorgeous display of lamps was the first thing to attract notice on entering the building. At the end of the hall three gas-engines—a ½-horse "Otto," a 2-man "Bisschop," and a 2½-horse "Leicester"—were in operation. Behind them, on a raised platform, were to be found blocks of the raw material from which gas is obtained; a model of gas-works (kindly lent by Mr. C. Hunt, of Birmingham), showing the process of obtaining it; the instruments employed in testing and registering its purity, illuminating power, and consumption; and, finally—and certainly by no means the least important—samples of the various residual products of its manufacture, and their commercial application in connection with the special branch of industry for which Coventry is famous.

A lady from the National Training School of Cookery at South Kensington was engaged to give at intervals short lectures on cooking, and the adaptability of gas-stoves for the purpose. In addition to this, some of the stoves were actually at work, the results being verified by an expert, and certified by the Gas Company's officials. A good opportunity was thus afforded of testing the capabilities of the exhibits, and of forming an opinion as to their working power.

There is, of necessity, a certain sameness about these exhibitions which renders any lengthy notice of them unnecessary. They are, nevertheless, worthy of being recorded, as they are each a step in advance in the work of extending the use of gas. In the present case, the action taken by the Coventry Gas Company may not result in an immediate increase in the gas consumption, but that it must eventually do so we fully believe; and we hope they may soon have to congratulate themselves on having held this exhibition, for the general success of which much is due to the exertions of their Manager, Mr. W. L. Robinson.

Société Technique de l'Industrie du Gaz en France.—The annual congress of the above Society will be opened in Paris on Monday next, and will probably extend over two or three days. The number of members who have already expressed their intention of being present, and the nature of the communications submitted, induce the belief that the meeting this year will be a particularly interesting one. It is highly probable that permission will be granted by the Paris Gas Company for the members of the Society to visit the new works now in course of erection at Clichy, and if this should be the case, we feel sure that all who avail themselves of it will derive much gratification therefrom.

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